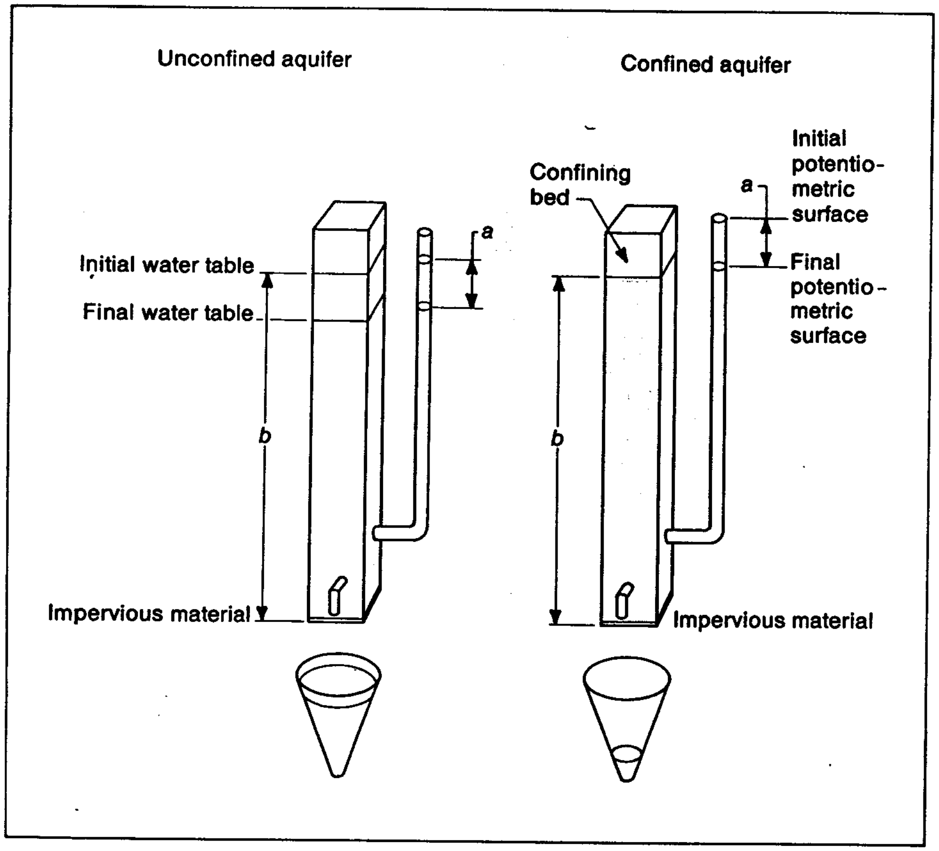


Figure 5.6. Unit prisms of unconfined and confined aquifers illustrating differences in storage coefficients. For equal declines in head, the yield from an unconfined aquifer is much greater than that from a confined aquifer. *(After Heath and Trainer, 1968)*

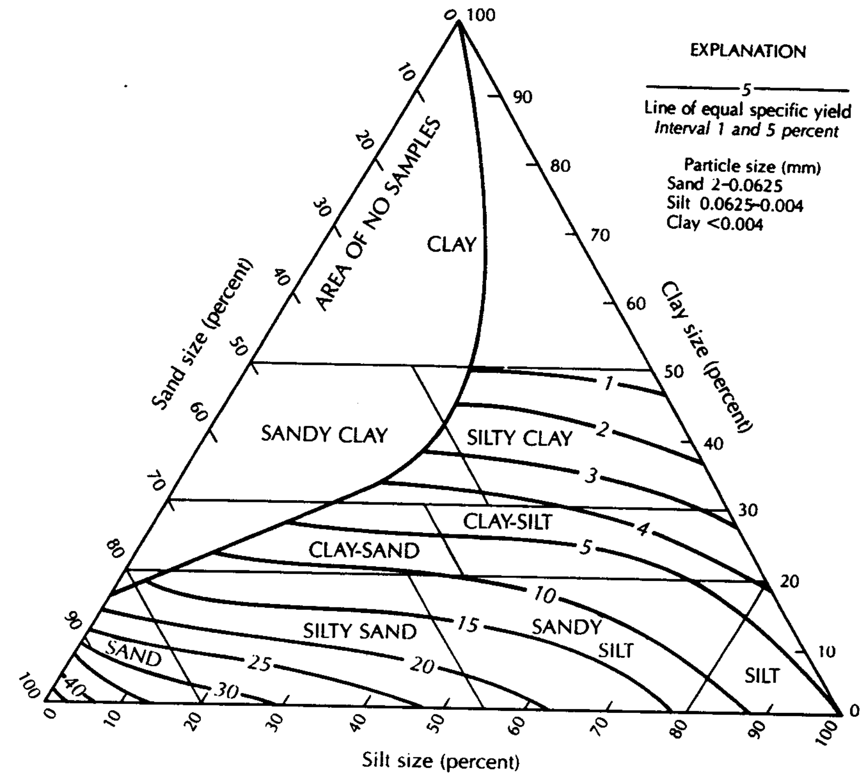


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

TABLE 4.4 Specific yields in percent

Material	Specific Yield Maximum	Minimum	Average
Clay	5	0	2
Sandy clay	12	3	7
Silt	19	3	18
Fine sand	28	10	21
Medium sand	32	15	26
Coarse sand	35	20	27
Gravelly sand	35	20	25
Fine gravel	35	21	25
Medium gravel	26	13	23
Coarse gravel	26	12	22

Source: Johnson (1967).

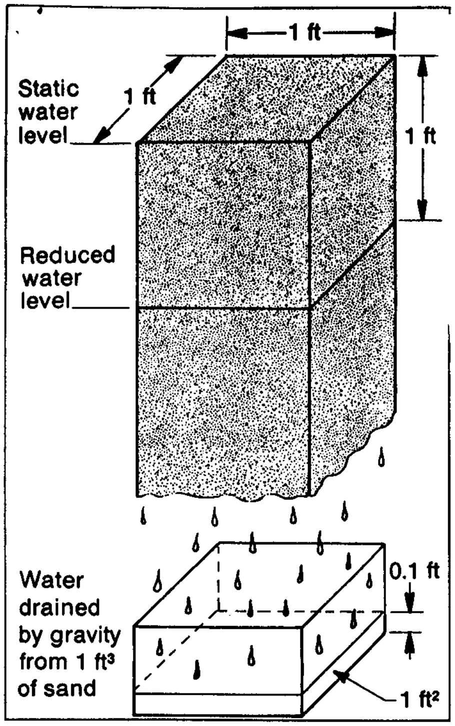


Figure 5.5. Specific yield of sand can be visualized from this diagram. Its value here is 0.1 ft³ per ft³ of aquifer material.

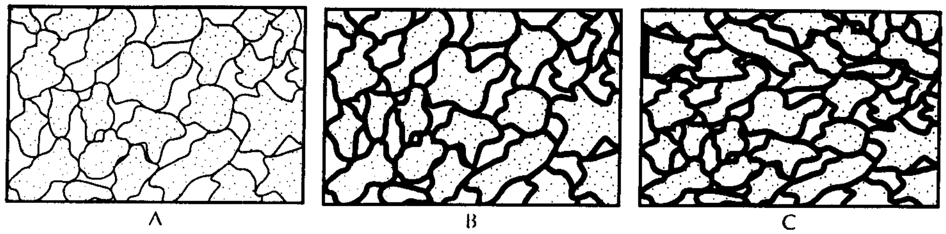
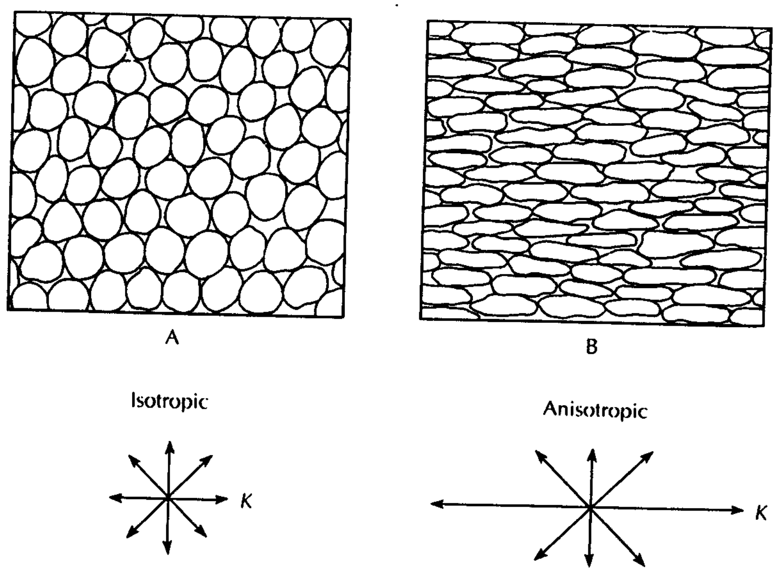


FIGURE 4.6 **A.** A clastic sediment with intergranular porosity. **B.** Reduction of porosity in the clastic sediment due to deposition of cementing material in the pore spaces. **C.** Further reduction in porosity due to compaction and cementation.

TABLE 4.3 Porosity ranges for sediments

Well-sorted sand or gravel	25–50%
Sand and gravel, mixed	20–35%
Glacial till	10–20%
Silt	35–50%
Clay	33–60%



AC

FIGURE 4.26 Grain shape and orientation can affect the isotropy or anisotropy of sediment.

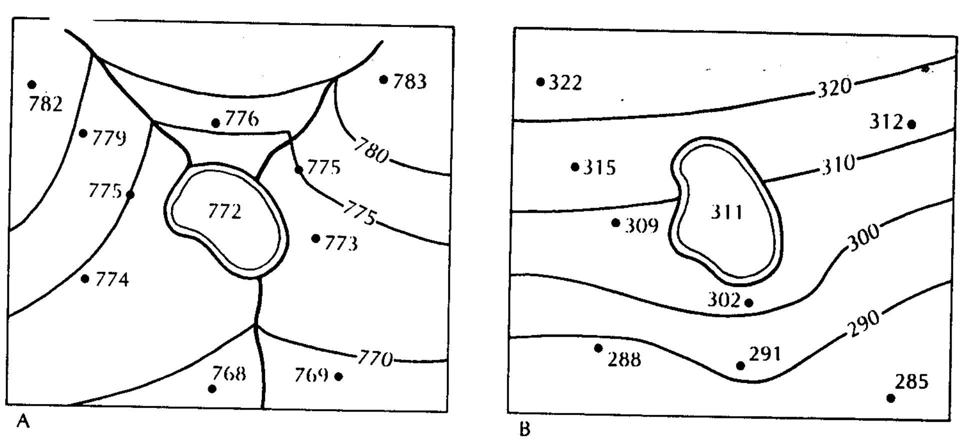


FIGURE 4.23 Maps showing construction of water-table maps in areas with surface-water bodies. **A.** A water-table lake with two gaining streams draining into it and one gaining stream draining from it. **B.** A perched lake that, through outseepage, is recharging the water table.

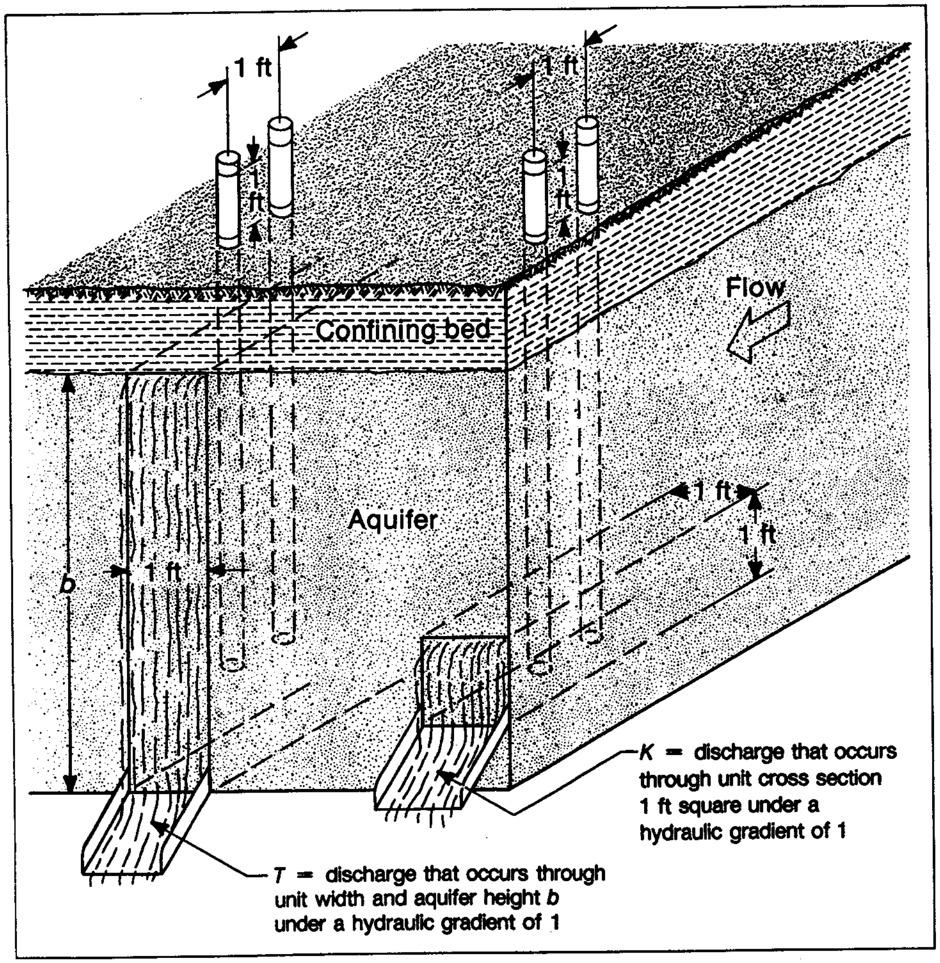


Figure 9.5. Illustration of the coefficients of hydraulic conductivity and transmissivity. Hydraulic conductivity multiplied by the aquifer thickness equals coefficient of transmissivity.

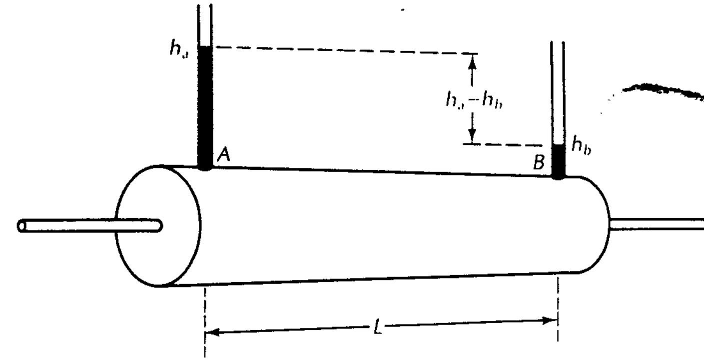


FIGURE 4.12 Horizontal pipe filled with sand to demonstrate Darcy's experiment. (Darcy's original equipment was actually vertically oriented.)

TABLE 4.5 Conversion values for hydraulic conductivity

1 gal/day/ft²	=	0.0408 m/day
1 gal/day/ft²	=	0.134 ft/day
1 gal/day/ft²	=	4.72×10^{-5} cm/s
1 ft/day	=	0.305 m/day
1 ft/day	=	7.48 gal/day/ft²
1 ft/day	=	3.53×10^{-4} cm/s
1 cm/s	=	864 m/day
1 cm/s	=	2835 ft/day
1 cm/s	=	21,200 gal/day/ft²
1 m/day	=	24.5 gal/day/ft²
1 m/day	=	3.28 ft/day
1 m/day	=	0.00116 cm/s

TABLE 4.6 Ranges of intrinsic permeabilities and hydraulic conductivities for unconsolidated sediments

Material	Intrinsic Permeability (darcys)	Hydraulic Conductivity (cm/s)
Clay	10^{-6}–10^{-3}	10^{-9}–10^{-6}
Silt, sandy silts, clayey sands, till	10^{-3}–10^{-1}	10^{-6}–10^{-4}
Silty sands, fine sands	10^{-2}–1	10^{-5}–10^{-3}
Well-sorted sands, glacial outwash	1–10^{2}	10^{-3}–10^{-1}
Well-sorted gravel	10–10^{3}	10^{-2}–1

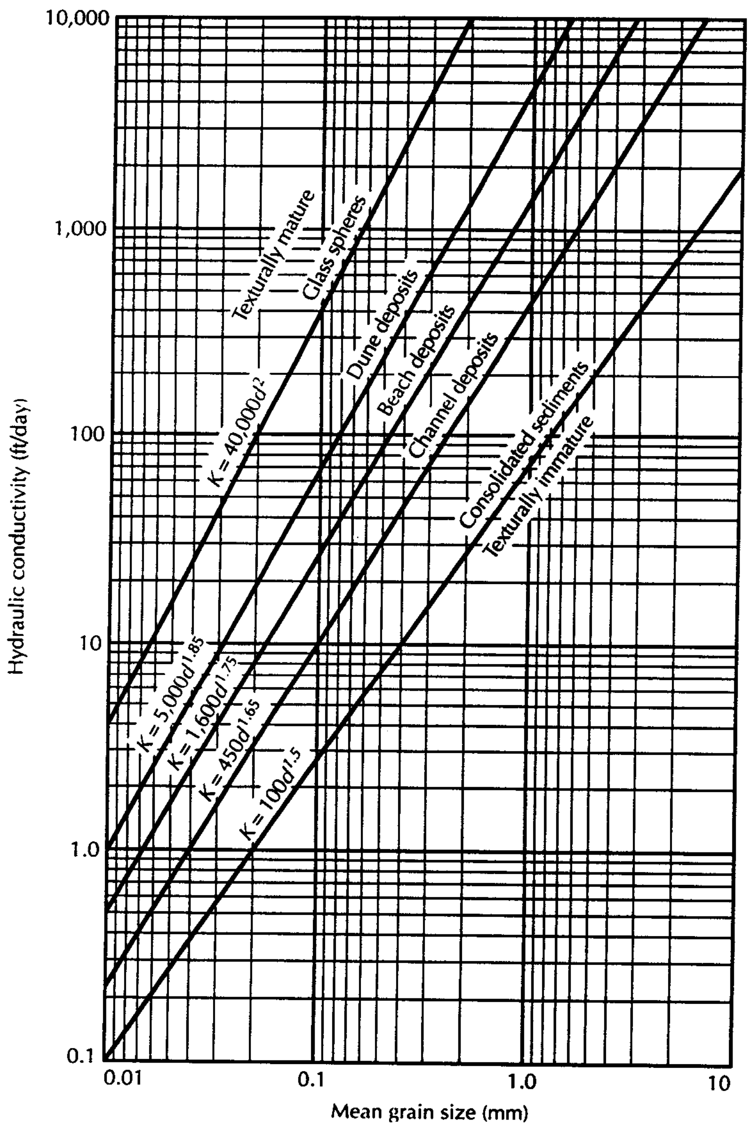


FIGURE 4.14 Graph showing the relationship of hydraulic conductivity to mean grain diameter for sediments of different textural maturity. Modified from R. G. Shepherd, *Ground Water* 27, no. 5 (1989): 633–638. Copyright © 1989 Ground Water Publishing Co.

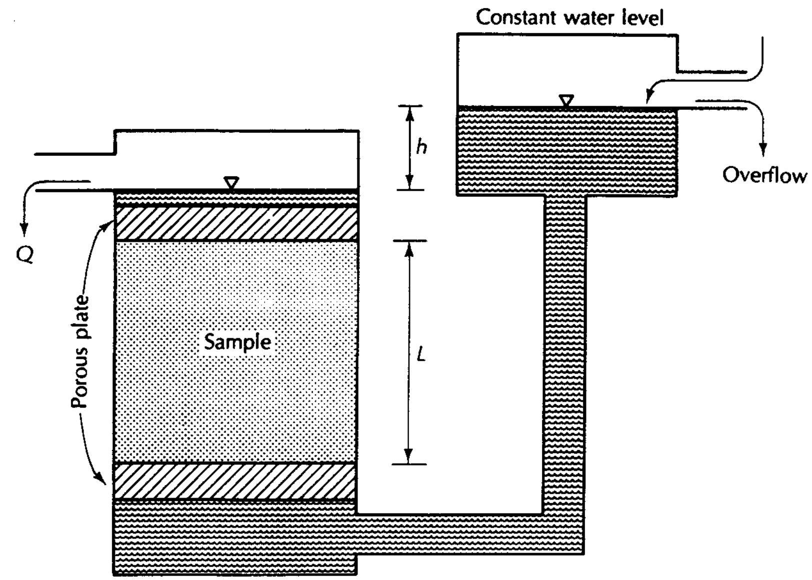


FIGURE 4.15 Constant-head permeameter apparatus.

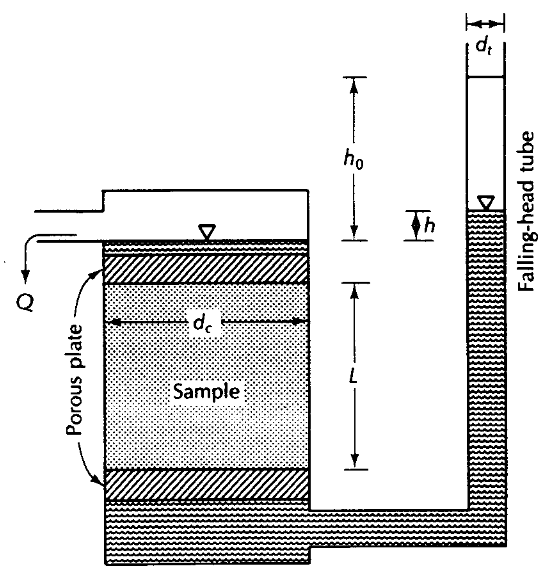
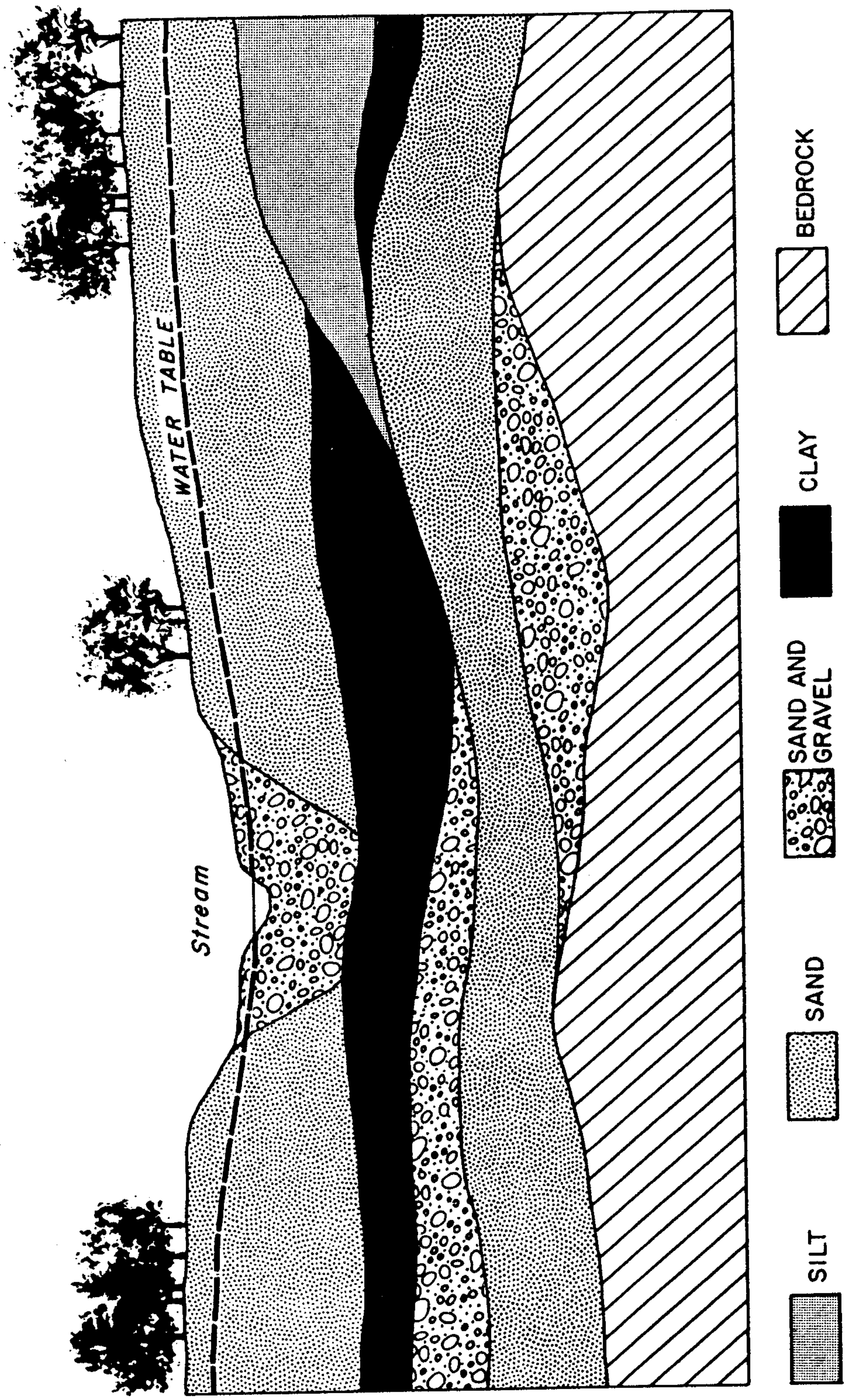
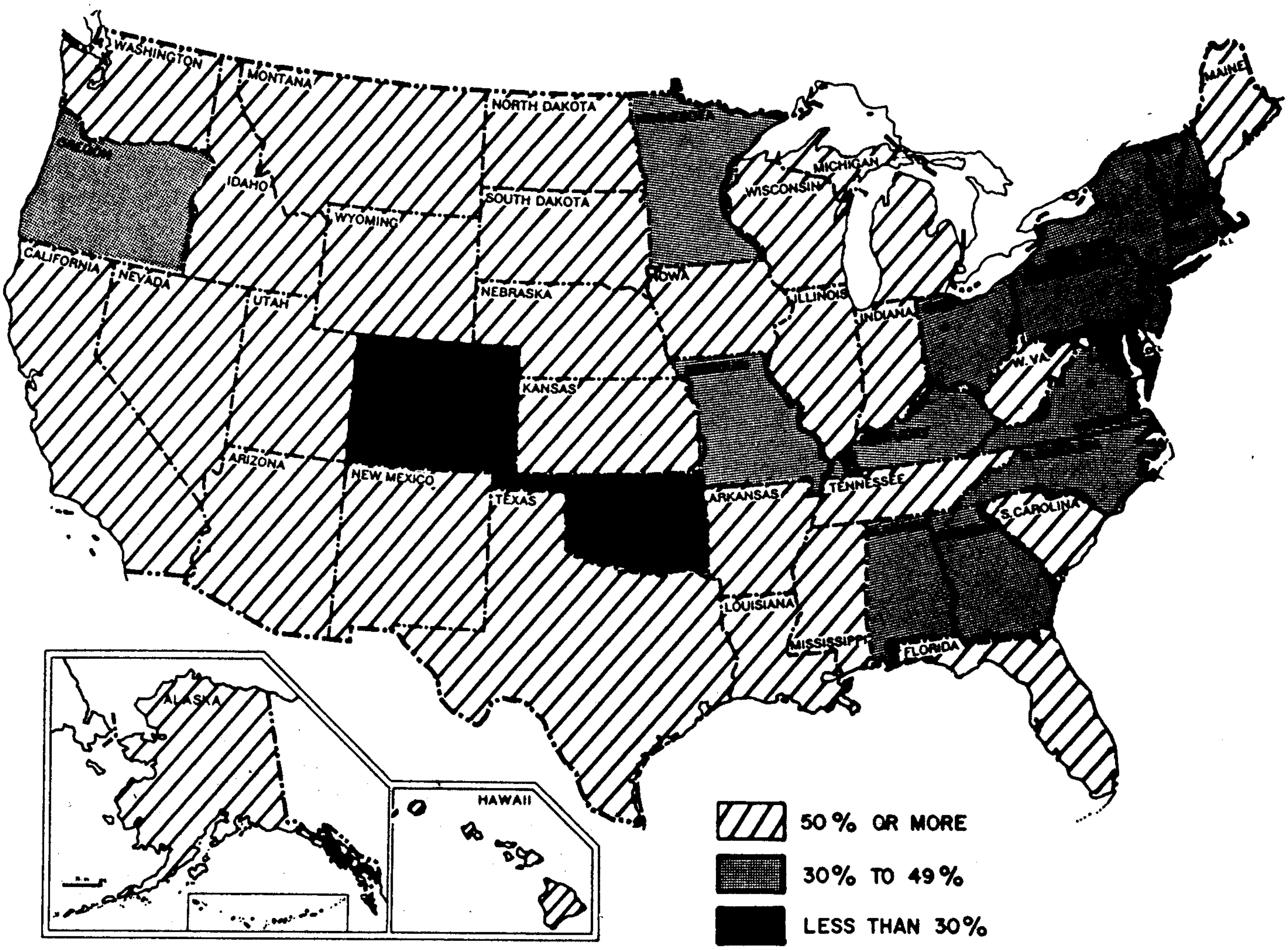


FIGURE 4.16 Falling-head permeameter apparatus.

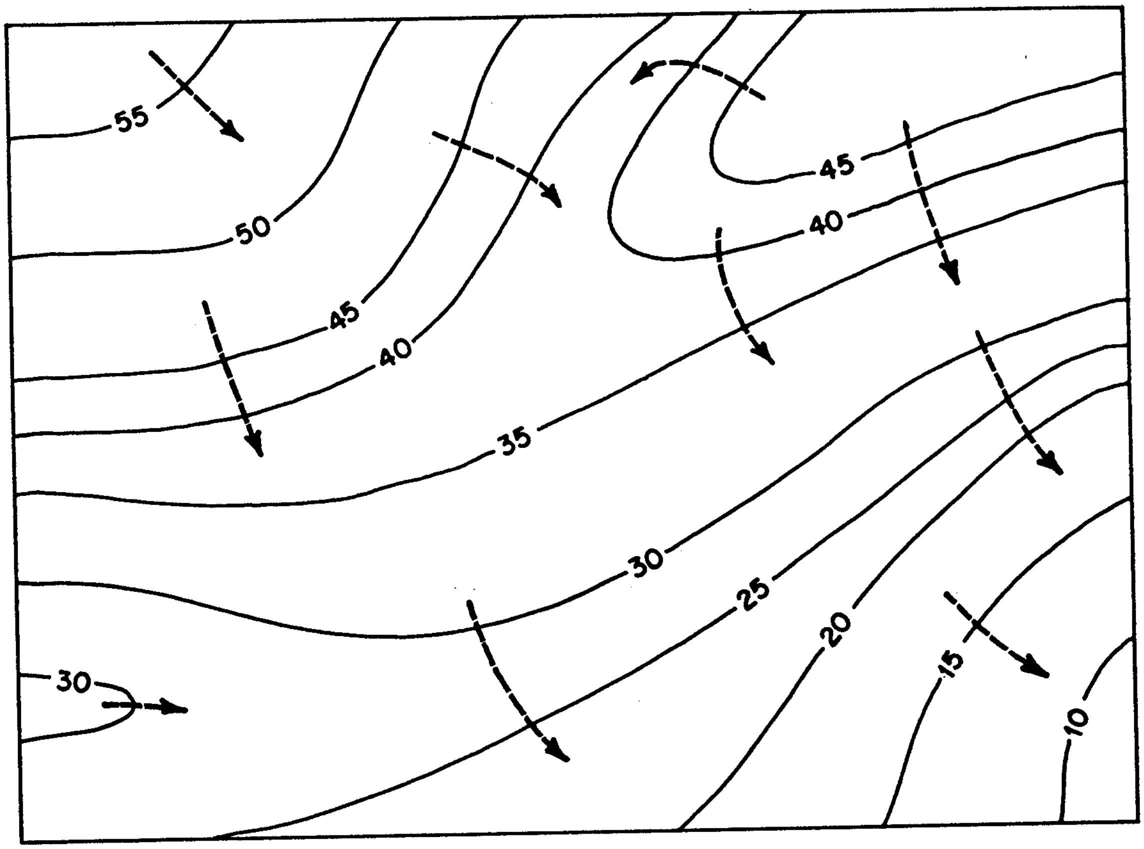


Geologic Cross Section

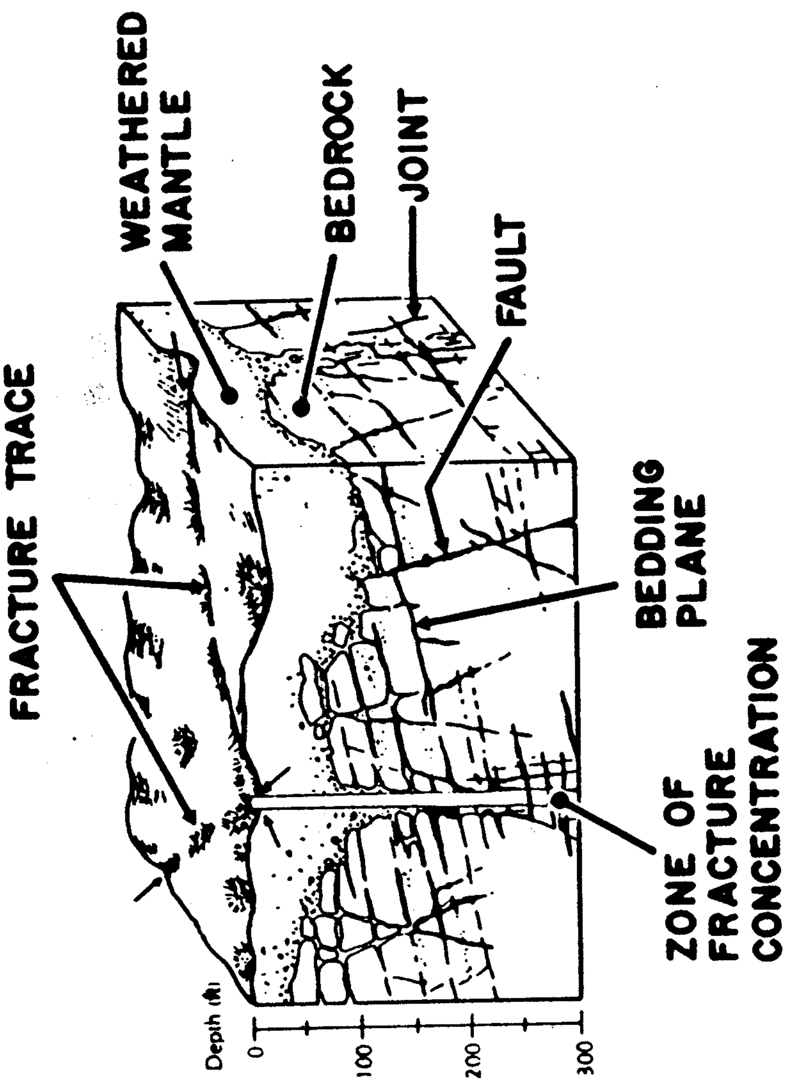


Percentages of People Relying on Groundwater for Domestic Use

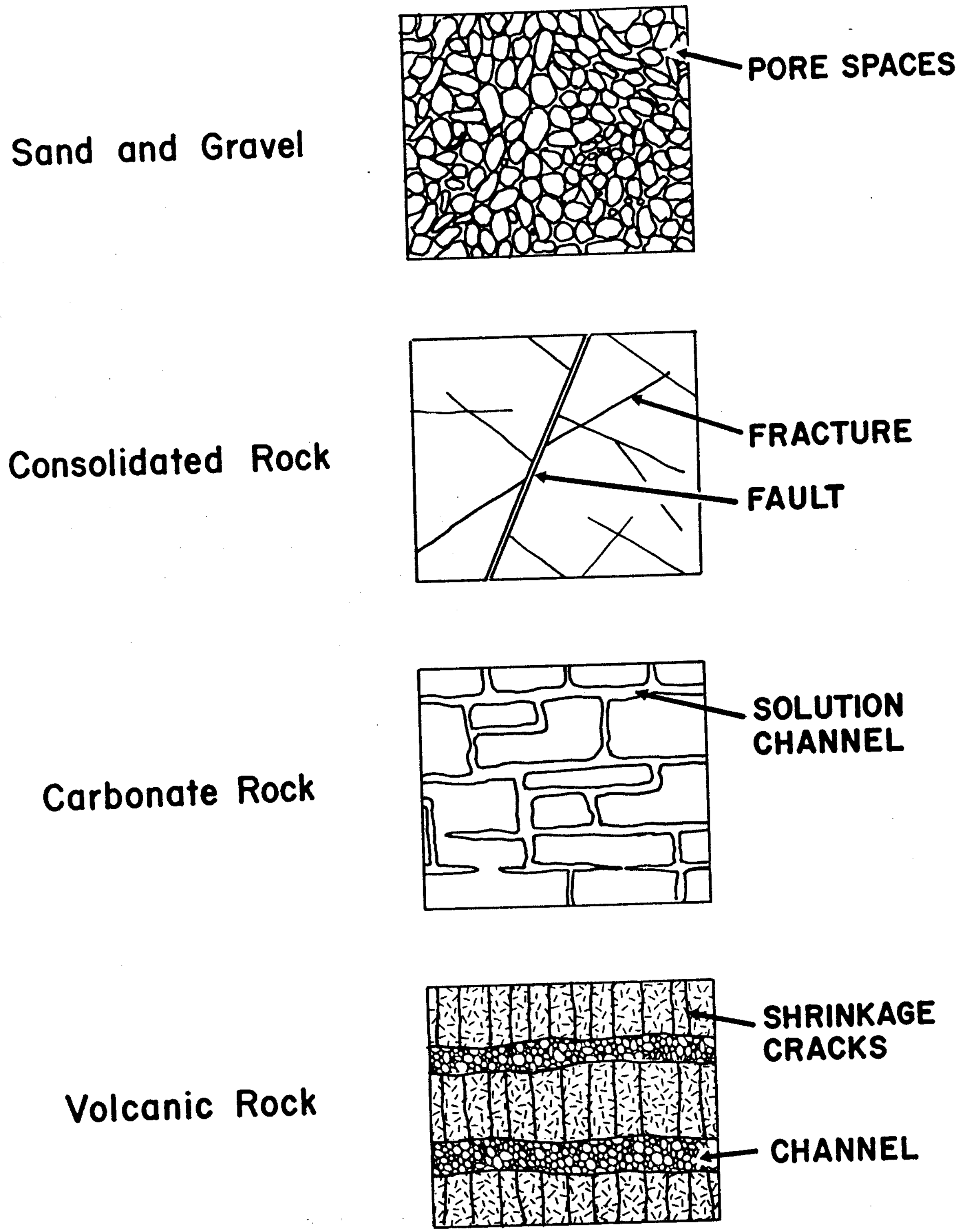
WATER TABLE



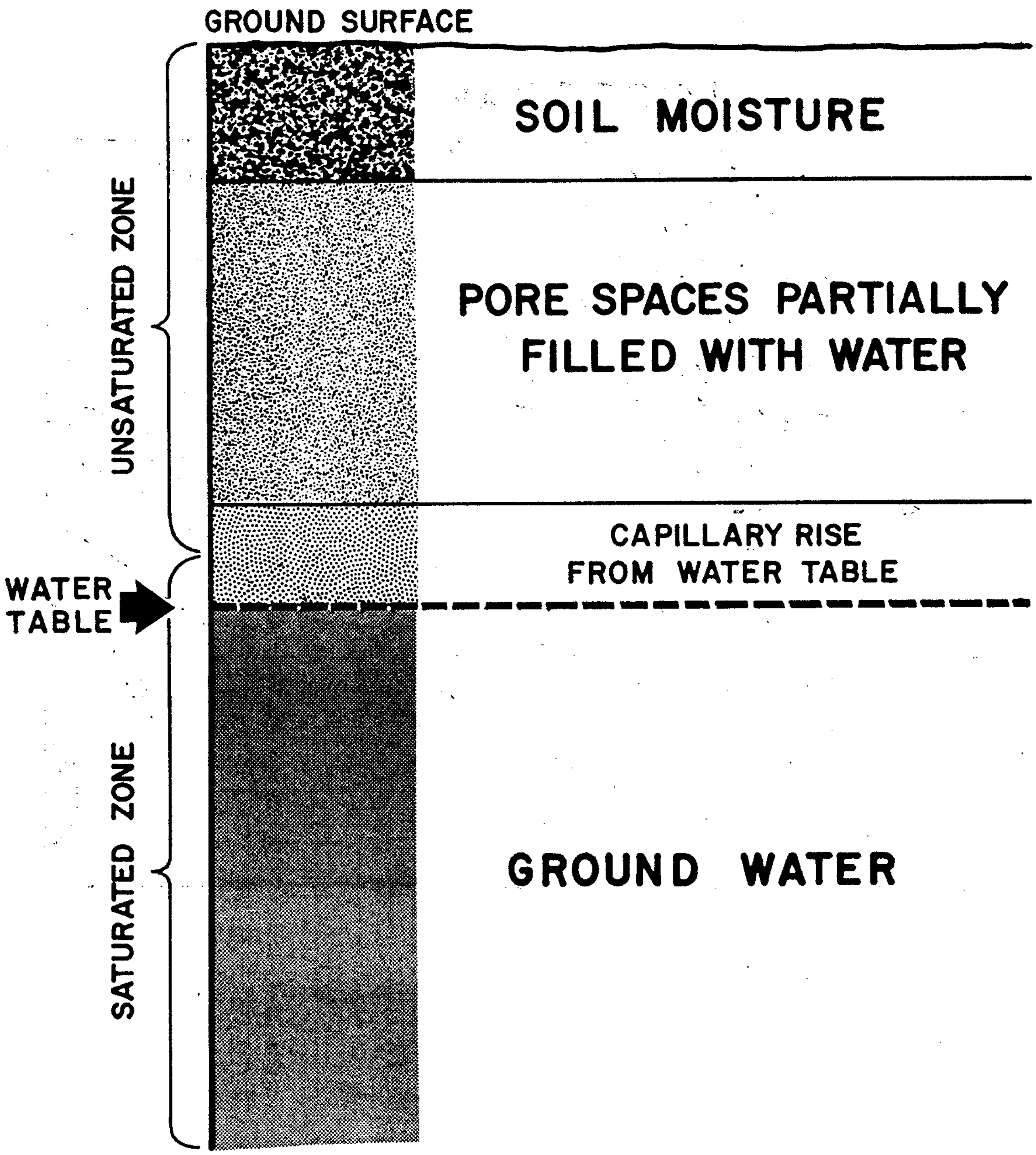
←- - - - DIRECTION OF FLOW



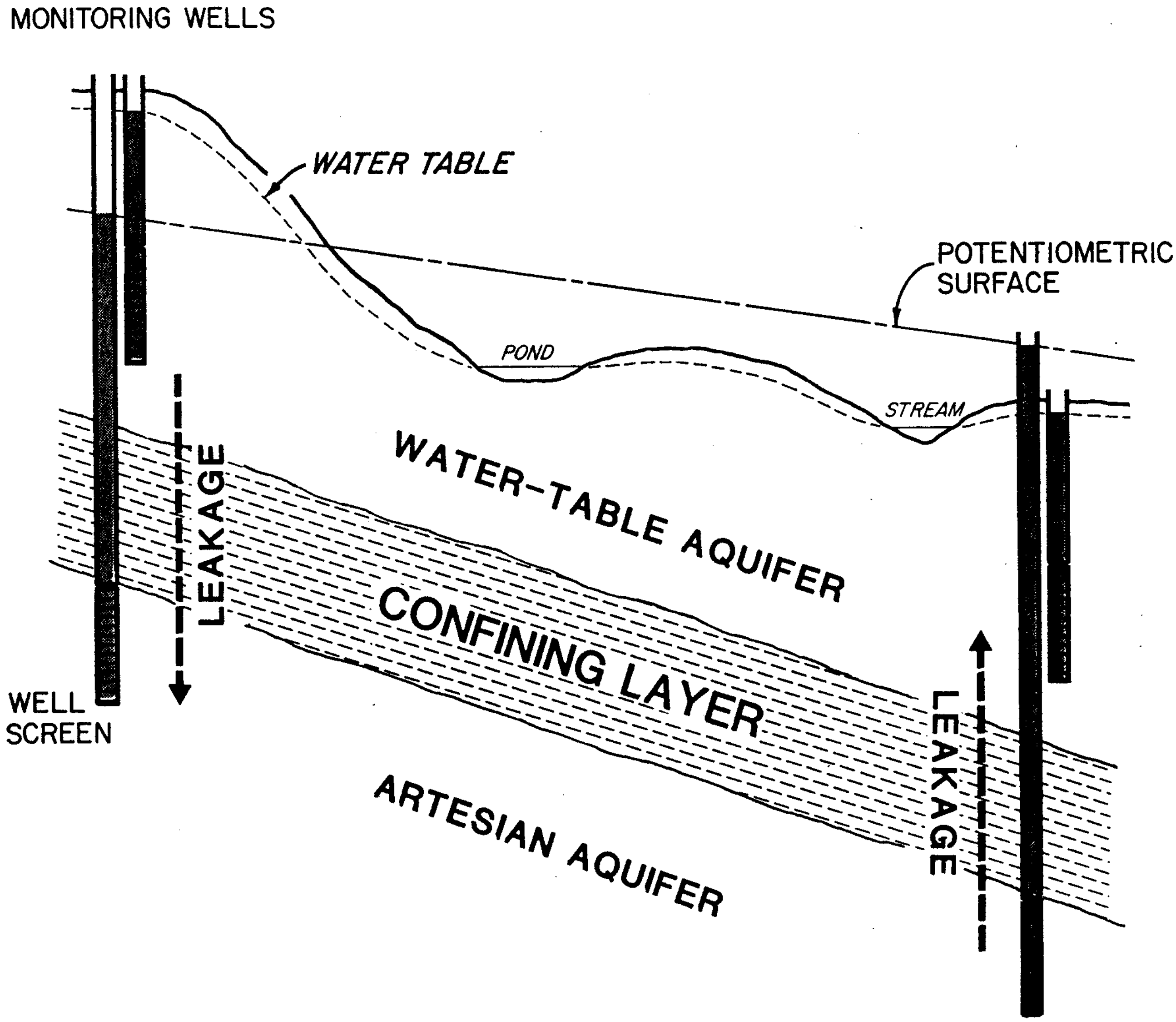
Principal flow paths in fractured rock (after Lattman and Parizek, 1964).



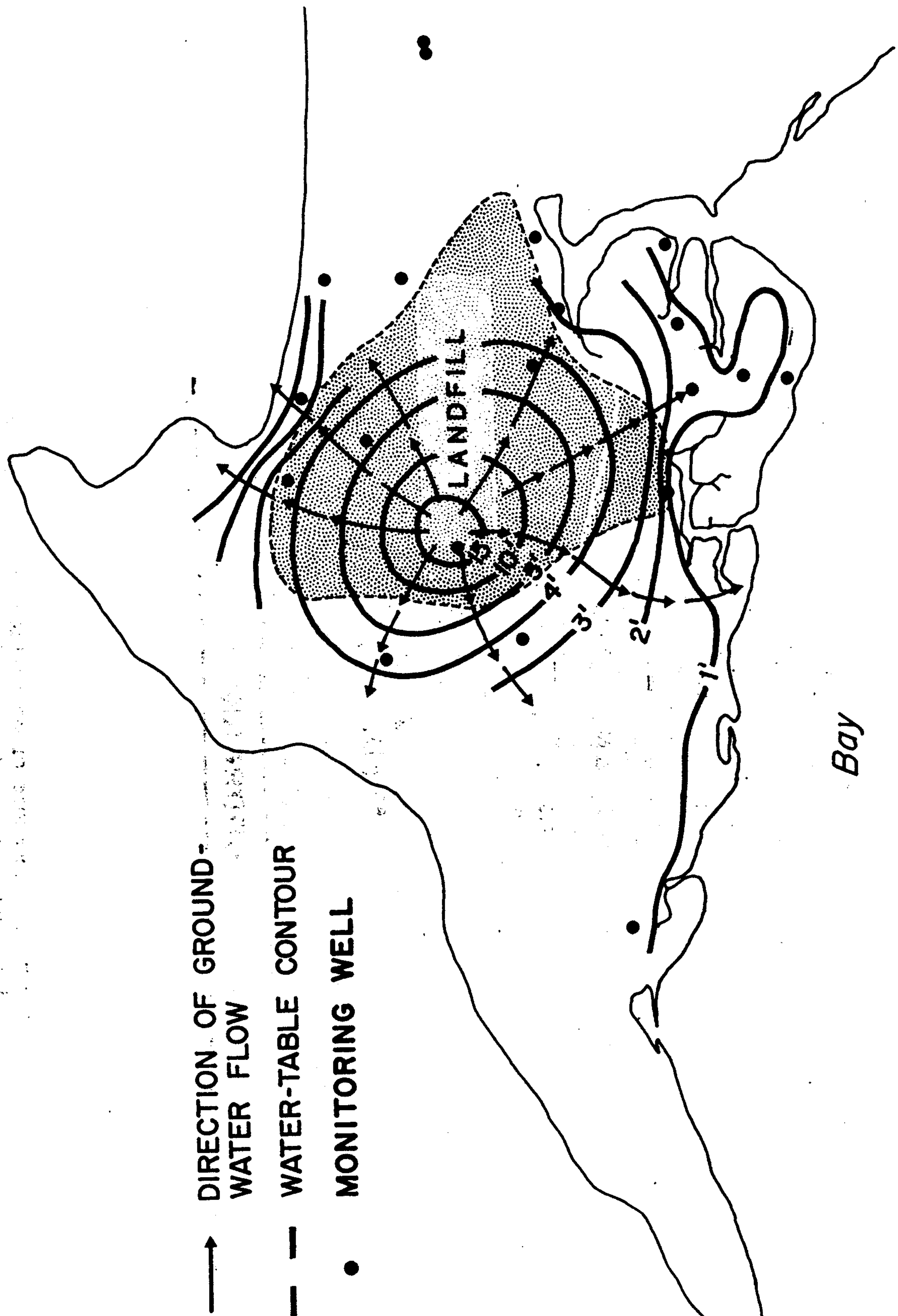
Rock texture in major aquifer types (Walton, 1970).



Relationship between unsaturated and saturated zones (after Edward E. Johnson, Inc., 1966).



Relationships within the hydrologic system.



Water-table configuration and directions of ground-water flow, Croton Point Landfill.

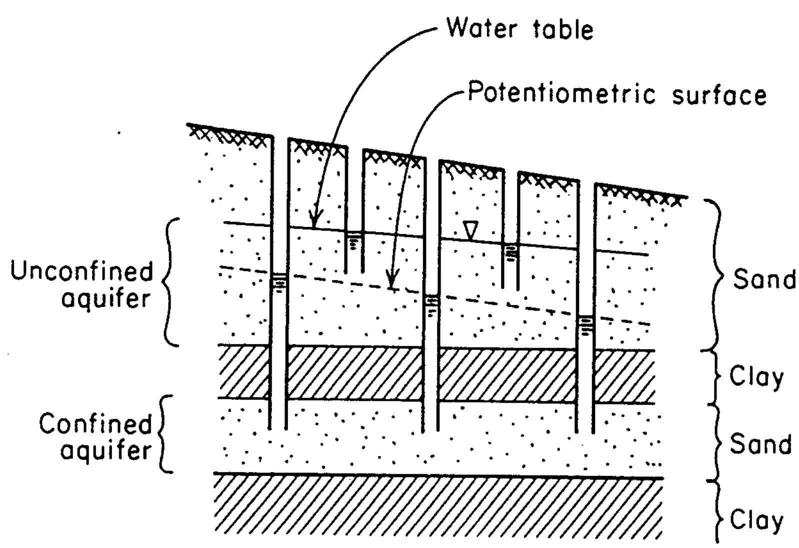


Figure 2.16 Unconfined aquifer and its water table; confined aquifer and its potentiometric surface.

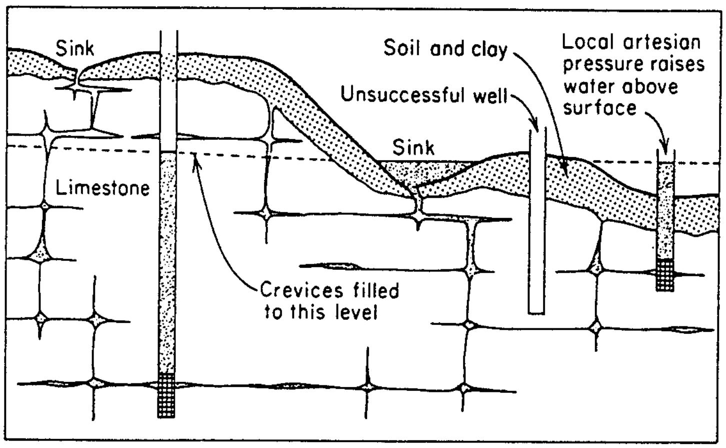


Figure 4.7 Schematic illustration of the occurrence of groundwater in carbonate rock in which secondary permeability occurs along enlarged fractures and ~~bedding plane~~ openings (after Walker, 1956; Davis and De Wiest, 1966).

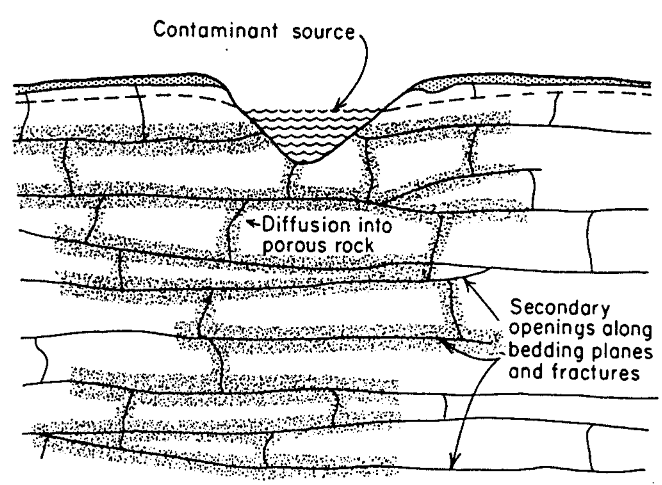


Figure 9.16 Schematic representation of contaminant migration from a surface source through fractured porous limestone.

15 m

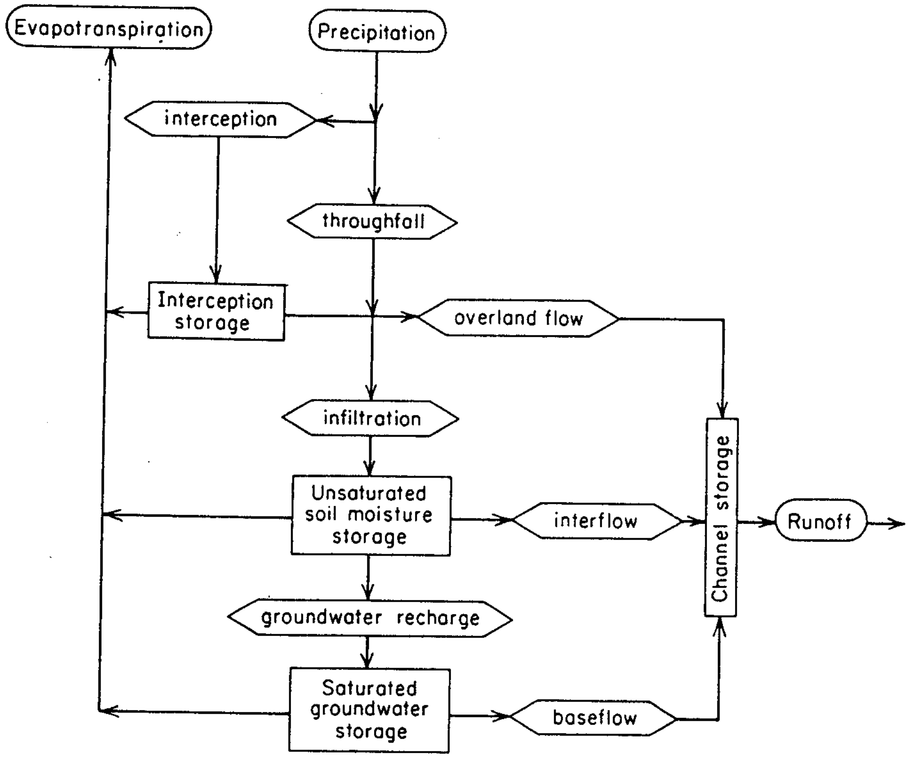


Figure 1.2 Systems representation of the hydrologic cycle.

Table 1.1 Estimate of the Water Balance of the World

Parameter	Surface area $(km^2) \times 10^6$	Volume $(km^3) \times 10^6$	Volume (%)	Equivalent depth (m)*	Residence time
Oceans and seas	361	1370	94	2500	~4000 years
Lakes and reservoirs	1.55	0.13	<0.01	0.25	~10 years
Swamps	<0.1	<0.01	<0.01	0.007	1–10 years
River channels	<0.1	<0.01	<0.01	0.003	~2 weeks
Soil moisture	130	0.07	<0.01	0.13	2 weeks–1 year
Groundwater	130	60	4	120	2 weeks–10,000 years
Icecaps and glaciers	17.8	30	2	60	10–1000 years
Atmospheric water	504	0.01	<0.01	0.025	~10 days
Biospheric water	<0.1	<0.01	<0.01	0.001	~1 week

SOURCE: Nace, 1971.

*Computed as though storage were uniformly distributed over the entire surface of the earth.

Table 1.2 Water Use in the United States, 1950–1970

	Cubic meters/day × 10⁶*					Percent of 1970 use
	1950	1955	1960	1965	1970	
Total water withdrawals	758	910	1023	1175	1400	100
Use						
Public supplies	53	64	80	91	102	7
Rural supplies	14	14	14	15	17	1
Irrigation	420	420	420	455	495	35
Industrial	292	420	560	667	822	57
Source						
Groundwater	130	182	190	227	262	19
Surface water	644	750	838	960	1150	81

SOURCE: Murray, 1973.

*$1\ m^3 = 10^3\ \ell = 264$ U.S. gal.

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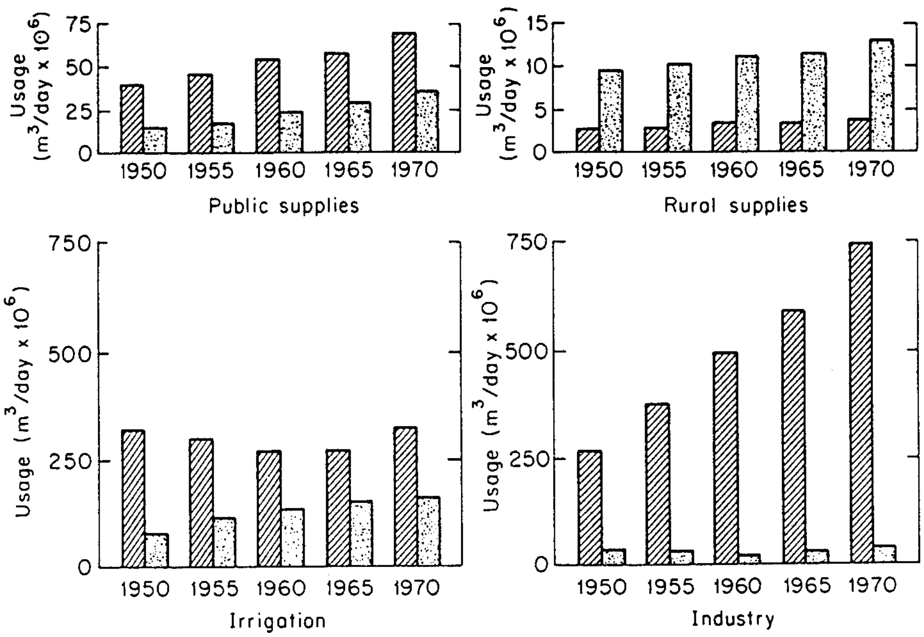


Figure 1.3 Surface water (hatched) and groundwater (stippled) use in the United States, 1950–1970 (after Murray, 1973).

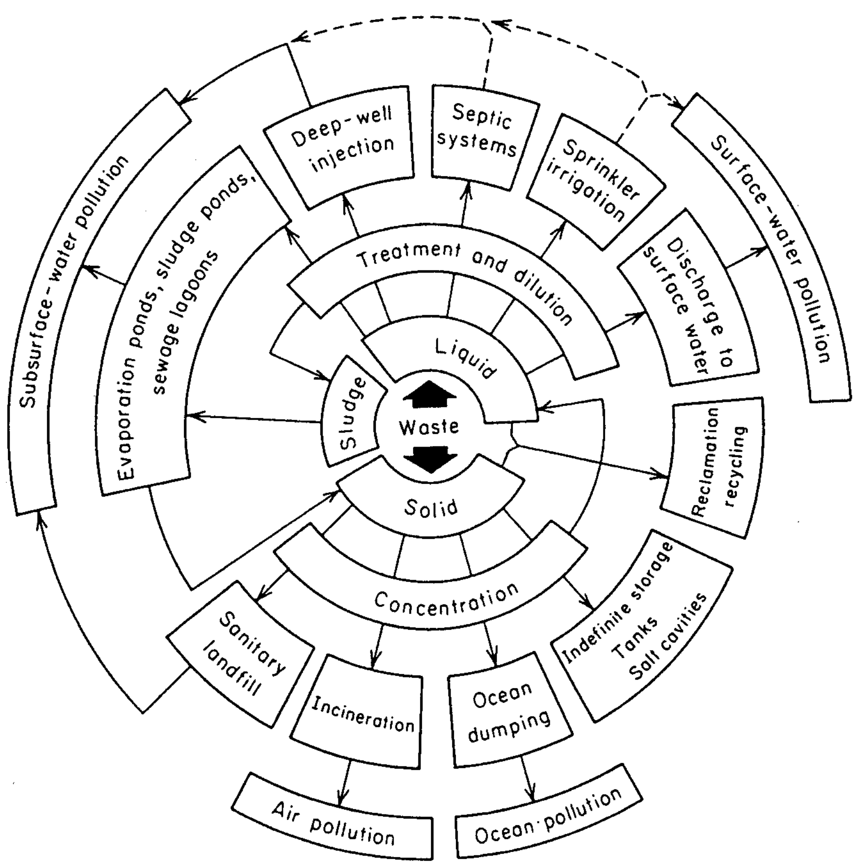


Figure 1.4 Spectrum of waste disposal alternatives.

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

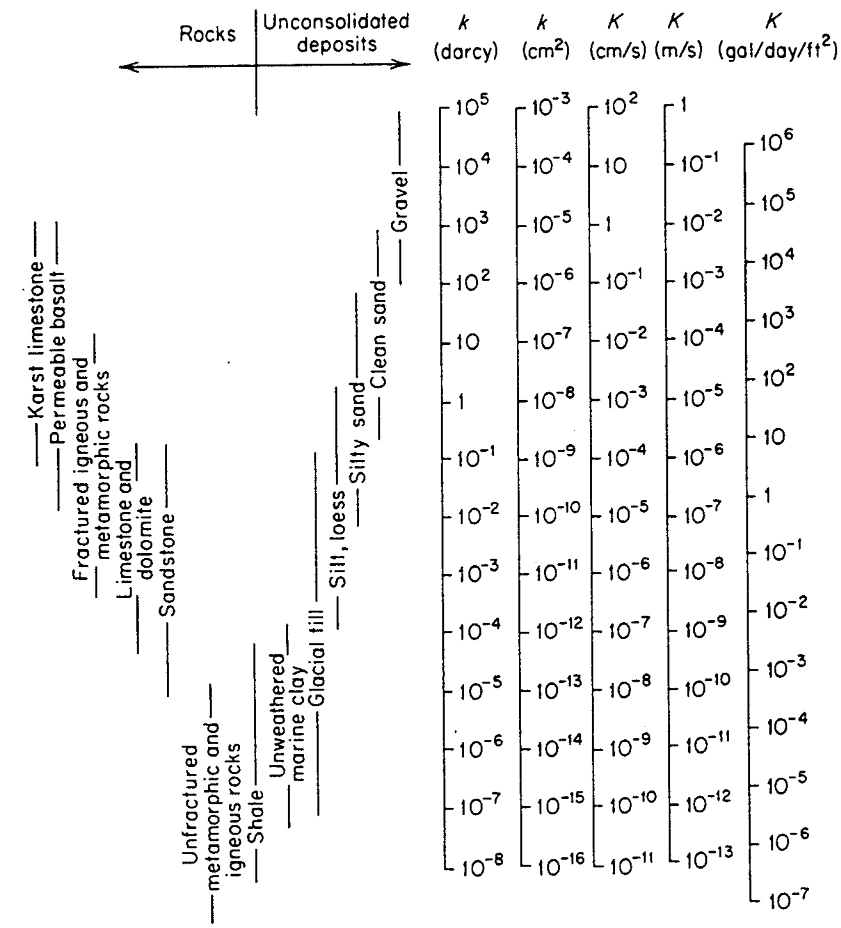
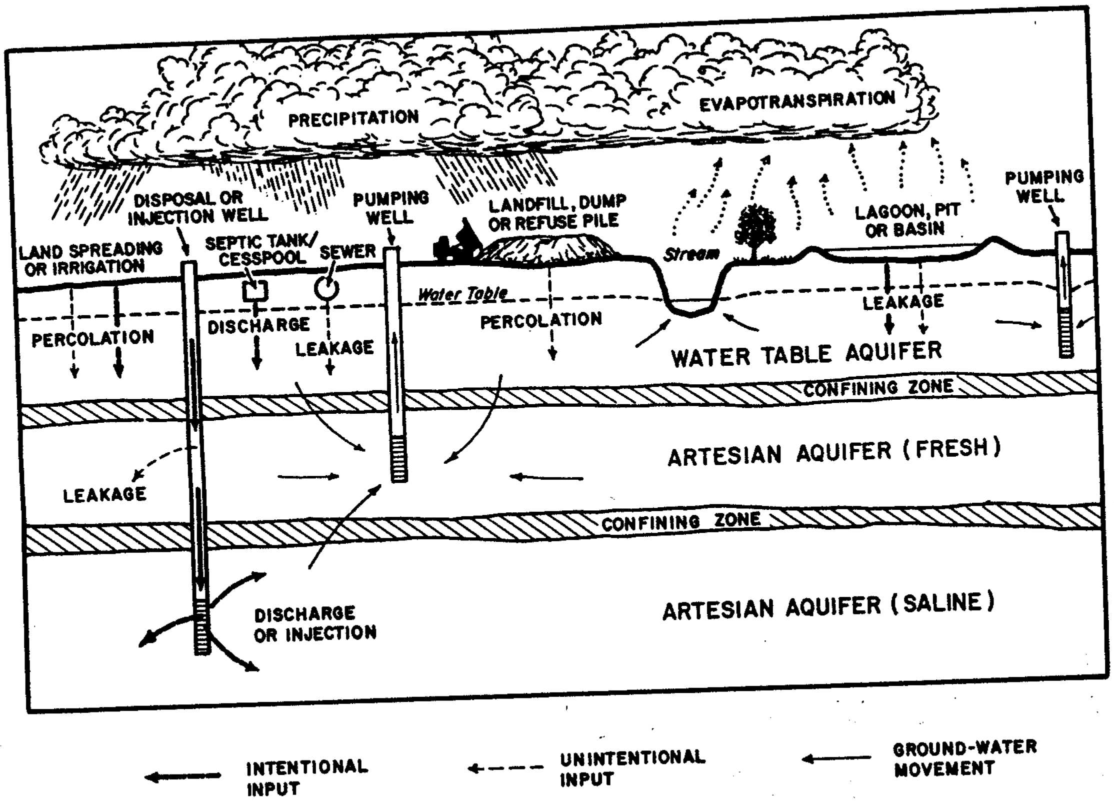


Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm^2	ft^2	darcy	m/s	ft/s	U.S. gal/day/ft^2
cm^2	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft^2	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft^2	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

*To obtain k in ft^2, multiply k in cm^2 by 1.08×10^{-3}.



Sources of ground-water contamination.